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BROILIELLUS, A NEW GENUS OF AMPHIBIANS FROM THE PERMIAN OF TEXAS

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The material upon which this genus is based comprises two specimens, Nos. 684 and 685, University of Chicago, collected by Mr. Paul Miller on Timber Creek, Texas. Both specimens, when found, were almost completely inclosed in hard clay nodules. The matrix has been removed from the surface of the bones very cleanly, but no attempt has been made to separate any of them. The larger and more complete of the two specimens, No. 284, the holotype, includes the complete skull, but very slightly distorted, connected with the complete series of dorsal shields; the right humerus in position with the somewhat crushed scapula; the incomplete clavicular girdle; the incomplete left humerus and a part of the hand; the right femur, tibia, fibula, three tarsals, and two metatarsals. There is also a fragment of the pelvis. Specimen No. 285, of slightly smaller size, has the complete skull less compressed than that of the other specimen. It also is connected with the complete series of dorsal shields, and their corresponding vertebrae; also the clavicular girdle is in place; and an imperfect humerus. Only slight indications of the ribs are present in either specimen.

SKULL

Few other specimens of amphibian skulls in the University collection are in better preservation. The skull is sub-triangular in shape, a little longer than broad, with the face broadly rounded in front. The nares are rather large; they are situated near the anterior extremity of the face, and are separated by about their own diameter. The orbits are rather large, nearly circular in outline, with their hind borders a little beyond the middle of the skull anteroposteriorly. In the middle of each orbit of the larger

specimen there are several osseous plates. Those of the left orbit seem complete; they form a continuous, convex surface, occupying more than half the diameter of the orbit. The plates are five or six in number; they are not arranged in a ring about a pupillary opening, but the surface is continuous. They could not have been sclerotic plates, and it seems not at all improbable that they were merely ossifications in a nictitating membrane, and served for the protection of the eyeball. The parietal foramen is of the usual size

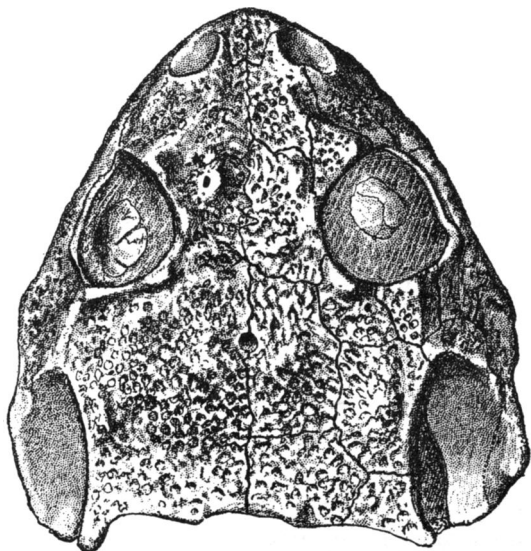


FIG. 1.—*Broiliellus texensis* Williston. Skull, from above, three-fourths natural size. No. 684, University of Chicago.

and is situated a little distance behind a line drawn through the hind margins of the orbits.

The otic notch is large, occupying most of the postero-lateral surface of the skull, and extending forward fully two-thirds the distance to the hind margin of the orbit. The ear-opening itself is rather large, extending forward more narrowly nearly to the front margin of the notch. Below the opening there is a broad, smooth surface, looking obliquely upward, backward, and outward. The excavation throughout is quite like that in the species from New Mexico provisionally referred to *Aspidosaurus* under the specific

name *A. novomexicanus* Williston. It is also like that of *Cacops* except that it is not closed behind. The tabulare is a little elongate posteriorly, but is not turned downward to meet the quadrate, as in *Cacops* and *Dissorophus*.

The surface of the skull is everywhere deeply marked with small, oval, or rounded pits. The most striking characteristic of the species, however, is the presence of numerous tubercular tuberosities, which must have given the animal when alive a peculiar aspect. Each element of the upper surface of the skull has at least one such

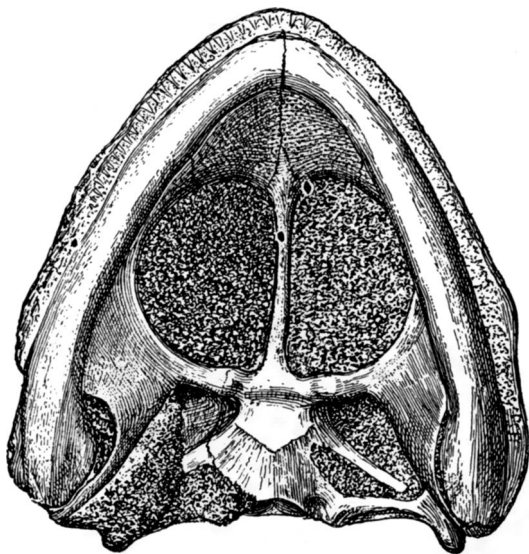


FIG. 2.—*Broiliellus texensis*. Skull, from below, three-fourths natural size. No. 684, University of Chicago.

spiny tubercle, and on each frontal there are at least two. The most prominent ones, however, almost approaching the character of short spines, are situated on the immediate margins of the orbits, one on each prefrontal, frontal, postfrontal, postorbital, and a smaller one below on each jugal.

The sutures throughout are easily distinguishable with the aid of a hand lens as slender, impressed, sinuous, or zig-zag lines. They have been corroborated throughout, not only on the two sides of each skull, but on the two skulls as well, though there is

a slight individual variation in their courses in the two skulls. The shapes and relations of the elements conform so closely to the



FIG. 3.—*Broiliellus texensis*. Specimen No. 684, University of Chicago. One-half natural size.

recognized plan in the temnospondyl skull that a detailed description of them will be superfluous. The lacrimal, as more usual in the temnospondyl skull, extends from the nares to the orbits, as has

been described and figured by Watson, and before him by Broili in *Cochleosaurus*.

The palate has been exposed only so far as is possible in each specimen with the mandibles tightly closed and the clavicular girdle in position. Doubtless the structure throughout is like that of *Cacops*,¹ but the nares and all evidences of enlarged teeth are concealed. The interpterygoidal vacuities are very large, though less elongated than in *Cacops*. Sutural lines for the vomers are apparent, as I have figured them. The whole surface in front, between the mandibles, is covered with minute chagrin-like teeth.

Indications of the stapes, as in *Cacops*, are present, as also the sutural division between the parasphenoid and the exoccipitals.

The sutures of the mandibles, in their closed condition, are not distinguishable. The teeth are shown in both specimens. They are small, pointed cones, of nearly uniform size, throughout.

DORSAL CARAPACE

The general shape of the dorsal shields is shown sufficiently well in the photograph of the larger specimen. In this specimen the vertebrae, with two exceptions, back of the clavicular girdle had been separated and lost before fossilization, as has been demonstrated by excavating the under side in the middle. In the smaller specimen, the vertebrae are all in position as far as the hind end of the carapace, though the last two or three are somewhat disarranged. Furthermore, in the smaller specimen, several of the shields have been cleanly removed from the matrix, proving that they had no connection whatever with the underlying spines; indeed they lie some distance above the vertebrae, with the matrix intervening. The plates in this specimen correspond in number with the vertebrae below, that is, each vertebra corresponds to a single plate and not to two as in *Cacops* and *Dissorophus*. The plates are not of uniform width anteroposteriorly; the third, fifth, and seventh at least are narrower than the intervening ones, which suggested at first that each vertebra had two plates, but this is positively not the case; all of which goes to prove that the plates were entirely distinct from the spines. Indeed the spines, so far

¹ Williston, *Bull. Geol. Soc. Am.*, 249, 1910.

as can be made out, are short and small. The first and last plates are larger than the others, the first subcrescentic in outline, the last oval, with its two diameters nearly equal. The carapace is broadest transversely in front, and tapers to the end. The shields are fifteen in number in each specimen, which singularly is the same number as that of *Cacops*, and probably also that of *Dissorophus*. Each plate is strongly pitted, like the surface of the skull. They are not at all imbricated, but lie side by side, touching each other in both specimens.

APPENDICULAR SKELETON

So far as the clavicular girdles are visible, they show but little difference from that of *Cacops*. The interclavicle and clavicle are smooth externally and are of moderate size; the clavicle has an elongate process for attachment to the scapula. The scapula is for the most part hidden below the carapace; that part which is visible is not unlike the scapula of *Cacops*. The humerus is stouter than in *Cacops*, the extremities are less dilated, and the lateral process is not as stout. What appears to be the right ulna and a part of the hand are shown on the same side of the block as that of the carapace. Six, perhaps seven, carpal bones are seen, together with indications of three fingers, the fifth one with the metacarpal and first phalange in place, the fourth and third represented by fragments of the metacarpals only. The hand clearly was short and broad.

Of the hind extremity, the right femur, tibia, fibula, three tarsals, and two metatarsals are in position. The femur has very prominent adductor crest like that of *Cacops*, but is distinctly stouter than in that genus. The tarsals are probably the third and fourth distalia and a centrale; and the metatarsals doubtless correspond with the distalia. The feet were evidently more elongate than the hands.

As regards the species, it is very probable the genus includes that to which I gave the name *Aspidosaurus peltatus* from the Craddock bone bed. However, inasmuch as there is yet no evidence of a slender inferior process on any of the shields of these specimens, the present species may be provisionally called *texensis*.

It gives me great pleasure to name the genus in honor of my friend Dr. Ferdinand Broili, who has contributed much to our knowledge of the American Permian vertebrates.

MEASUREMENTS

	684	685
Length of skull in midline.....	92	80
Width posteriorly.....	85	74
Anteroposterior diameter of orbits.....	24	20
Interorbital width.....	27	25
Length of carapace.....	120	100
Greatest width of carapace.....	43	36
Length of humerus.....	46	
Length of femur.....	54	
Length of tibia.....	35	
Length of median metatarsal.....	12	

The present genus is the fifth that has been described of the peculiar "batrachian armadillos" from the Permocarboniferous of Texas and New Mexico, namely: *Dissorophus* Cope, *Cacops* Williston, *Aspidosaurus* Broili, *Algeinosaurus* Case, and *Broiliellus* Williston. The first two of these genera may at once be differentiated by the completely closed otic notch; *Aspidosaurus* and *Broiliellus* have the otic notch open behind; in *Algeinosaurus* the skull is unknown. *Aspidosaurus* has typically a single dorsal shield for each vertebra, firmly co-ossified to the expanded spine of the vertebra, the shields are roof-shaped and narrow transversely. *Algeinosaurus* has imbricated shields like those of *Aspidosaurus*, narrow and shallowly V-shaped, but free from the broadly expanded neural spines. It is possible that this freedom of the shields is due to age, for I am convinced that the shields in all these forms are of dermal origin. Until the skull of *Algeinosaurus* is discovered its precise relations to the other genera cannot be determined. I am convinced that it is nearly related to *Aspidosaurus*, but believe that it is a distinct genus. It will at once be distinguished from the present genus by the narrow, shallowly V-shaped, imbricated shields.

Aspidosaurus glascocki Case can only be provisionally located in this group. Its dorsal shields seem to be real expansions of the spines, meeting each other closely, but not imbricated. Nor can *A. crucifer* and *A. apicalis* be located here. I am confident that all these forms belong in an entirely distinct group, possibly the Zatrachydidae.

That all the forms discussed above show a genetic relationship there can be no doubt. Just what value the differential characters present, however, is a question. If we give to *Dissorophus* and

Aspidosaurus family rank it will be necessary to erect a larger group to comprise them all. I would rather place them all in the family Dissorophidae, in two subfamilies, the *Dissorophinae* and *Aspidosaurinae*.

Family Dissorophidae

Temnospondyl amphibians of small size, provided with dorsal osseous shields. Skull broad, depressed, more or less rugose, without mucous canals. Lacrimal entering orbit. Probably orbital ossifications in all. Otic notch greatly developed, extending far toward the orbit. Palate with slender parasphenoid; in front at least covered with chagrin-like teeth; two enlarged teeth only. Occipital condyles separated. Cleithrum large; clavicles and interclavicle small, not sculptured. Sacrum with two vertebrae (in all?); pelvis fully ossified, platelike. Femur with high, thin adductor crest. Feet fully ossified, short and rather broad. No ventral armature.

Subfamily DISSOROPHINAE

Otic notch closed posteriorly by the union of tabulare with quadrate below. Each vertebra with two dorsal shields, the under one either an expansion of the spine or a dermal ossification and smooth, the intercalated external shields sculptured.

Genus *Dissorophus*

Shields covering nearly the whole of the dorsum, the first one of large size.

Genus *Cacops*

Shields narrow, the first one small.

Subfamily ASPIDOSAURINAE

Each vertebra covered by a single, sculptured shield. Otic notch open behind. Ribs with uncinat process.

Genus *Aspidosaurus*

Spines greatly expanded above, with shields not much wider than vertebrae, and imbricated; more or less V-shaped. Orbits more posterior.

Genus *Algeinosaurus*

Like *Aspidosaurus* but the shields not coossified with spine.

Genus *Broiliellus*

Shields much broader than the vertebrae, not imbricated and not V-shaped; free from slender neural spines; skull spinose.

Dissorophus multicinctus Cope. Texas.

Cacops aspidophorus Williston. Texas.

Aspidosaurus chiton Broili. Texas.

Aspidosaurus novomexicanus Williston. New Mexico.

Algeinosaurus aphthilos Case. Texas.

Broiliellus texensis Williston. Texas.

Broiliellus peltatus Williston. Texas.